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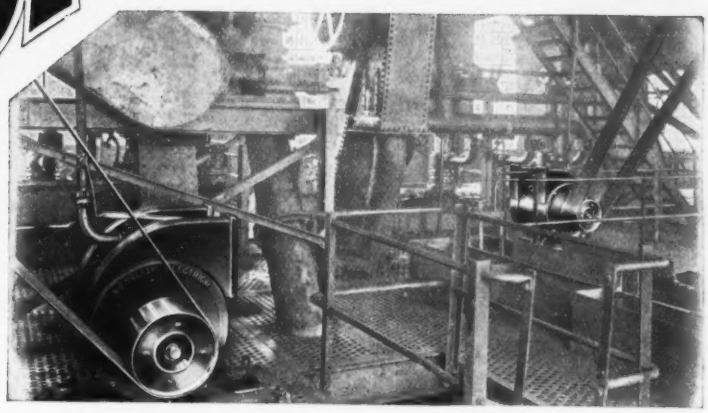

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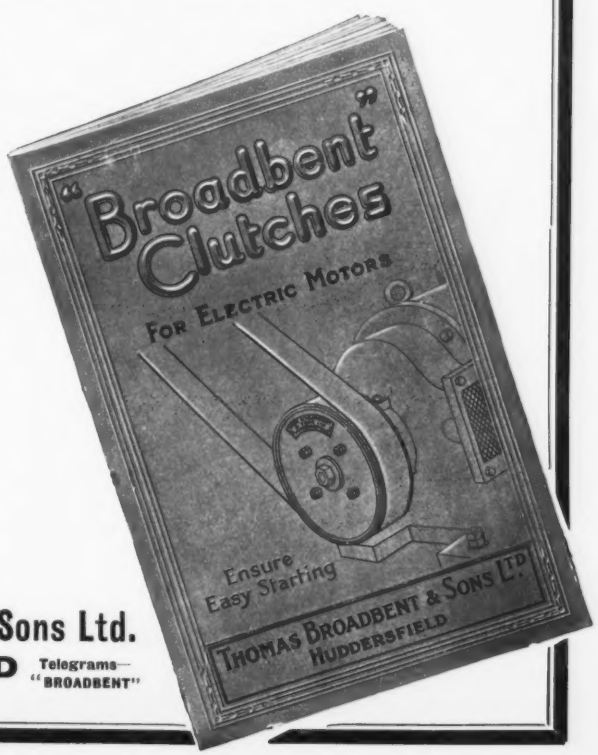

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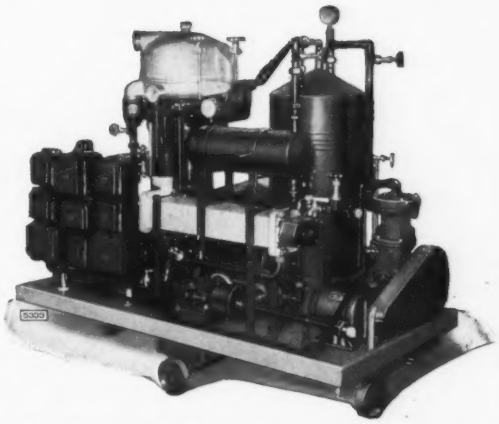

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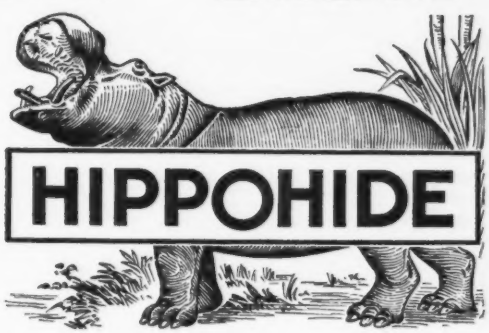

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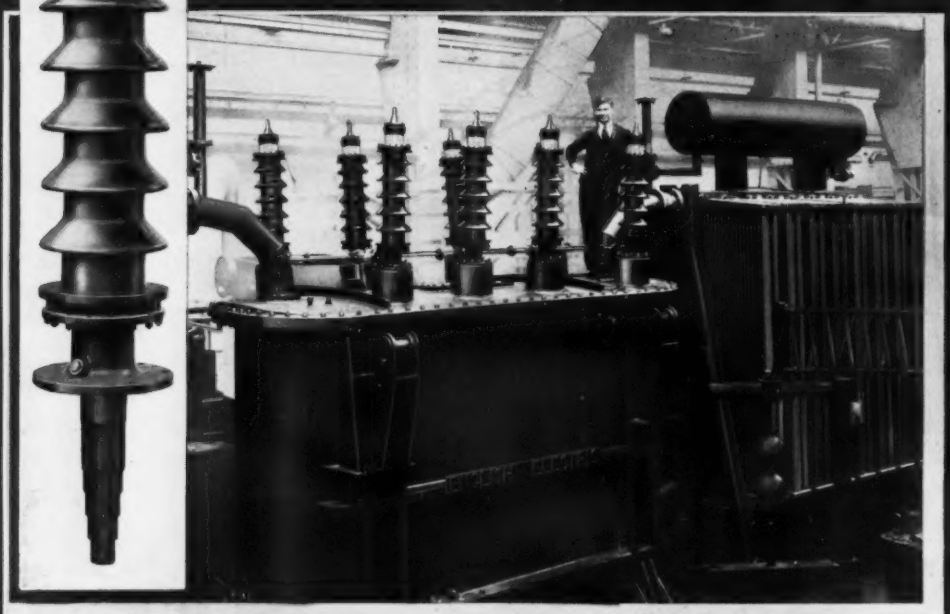

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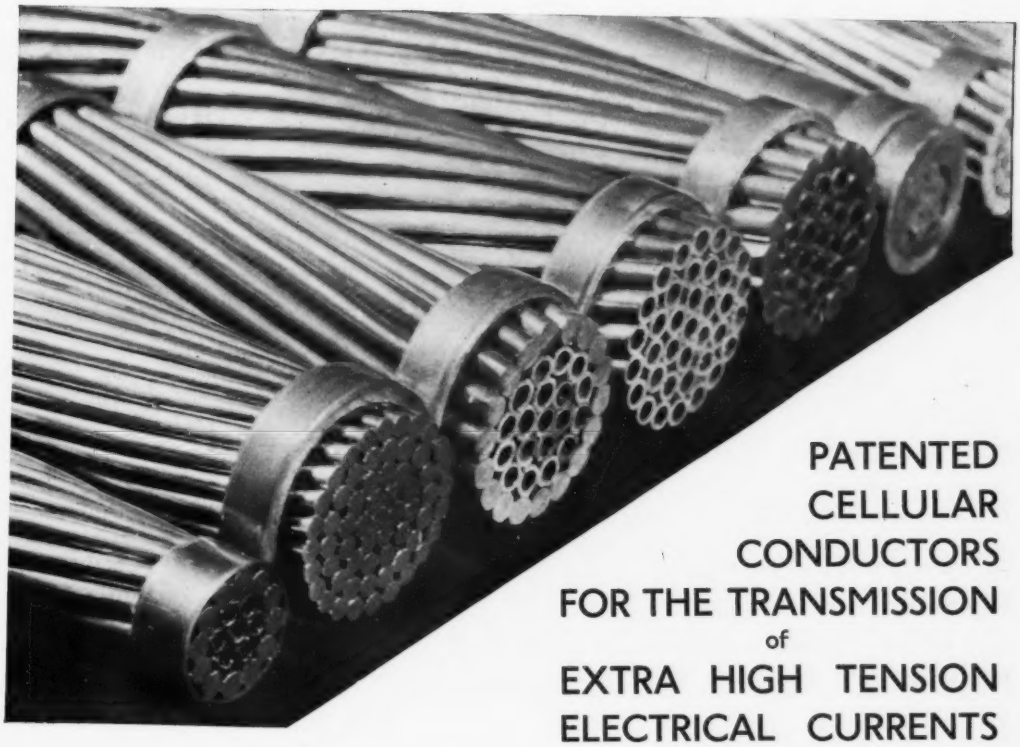

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The English Electric Journal

Vol. VI. No. 2 JULY, 1932 One Shilling.

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All Communications respecting Editorial Contents should be addressed to THE EDITOR, THE ENGLISH ELECTRIC JOURNAL, THE ENGLISH ELECTRIC COMPANY LIMITED, STAFFORD.

EDITORIAL.

The De-ionising Method of Arc Control and its application to oil circuit-breakers are illustrated and described in this issue. The improvement of oil breakers so that they may provide more reliable control of the large quantities of power that are transmitted over modern systems, is a need to which supply engineers and designers of high-voltage switchgear are very much alive in these days, and for some years investigators in all parts of the world have been studying the occurrences attending the operation of e.h.t. breakers in order to discover a scientific basis for their design. While progress has been made in ascertaining the factors which determine satisfactory performance, and a number of attempts have been made to control those factors, certain practical difficulties have prevented most of the proposed designs from receiving any general acceptance by engineers as a successful solution of the problem.

The De-ion Contact has the advantage of being a very simple means of bringing the arc under control throughout the

whole course of the movements which interrupt the circuit, and of influencing the arcing time and arc energy to an extent that is largely proportional to the power interrupted. The design is such that in many cases existing circuit-breakers can be modified so as to incorporate the special features of the de-ionising system.

Not only has the system been in practical service for a considerable time in circuit-breakers operating under a wide variety of conditions, but numerous comparative tests furnish convincing evidence of the greatly increased reliability of operation which it affords, as well as of the reduced maintenance expenditure.

The contents of this number serve, once again, to illustrate the great variety of the Company's products, and indicate also the policy of active development which it pursues in continually modernising its designs and extending the field of its manufactures. In addition to the important advance in circuit-breaker practice to which reference has just been made, special attention is drawn to the important work carried out at Preston in the design and construction of the bodies for all classes of public vehicles operated by engines of the oil-fuel class, especially for omnibuses with petrol or heavy-oil engines.

The experience and equipment of the Preston Works in relation to the building of transport vehicles is unique so far as this country is concerned, both in point of time and in variety, but at no period in its history has it been more active than to-day, in its efforts to produce vehicles which offer increased economy to the operating concerns and improved facilities to the public. It is satisfactory to conclude from the large number of repeat orders received this year for bus-bodies, that the Company's products and service have been appreciated by its clients, and it is interesting to notice that the special type of body exhibited at the Commercial Motor Transport Exhibition last year is being widely adopted.

Danish State Railways Award Contract for their First Electrification to the English Electric Company.

The Suburban services of Copenhagen are to be converted to electric working on the high-pressure direct-current system at 1,500 volts, and the English Electric Company will be responsible for the complete electrical equipments for 42 motor coaches and 21 trailer coaches.

By the award of this contract the number of countries in the world in which "English Electric" railway equipments are operating will be brought up to seventeen, and the Danish State Railways will be the fifty-sixth railway of the world to be electrified with the Company's material.

It is interesting to recall that the first high-voltage direct-current line operating in the world was the Bury-Holcombe Brook route of the Lancashire & Yorkshire Railway, for which the English Electric Company developed in 1913 direct-current motors and control gear for operating on 3,600 volts.

STAFFORD AT NIGHT

STAFFORD AT NIGHT

Electrification of the Howrah Jute Mills.

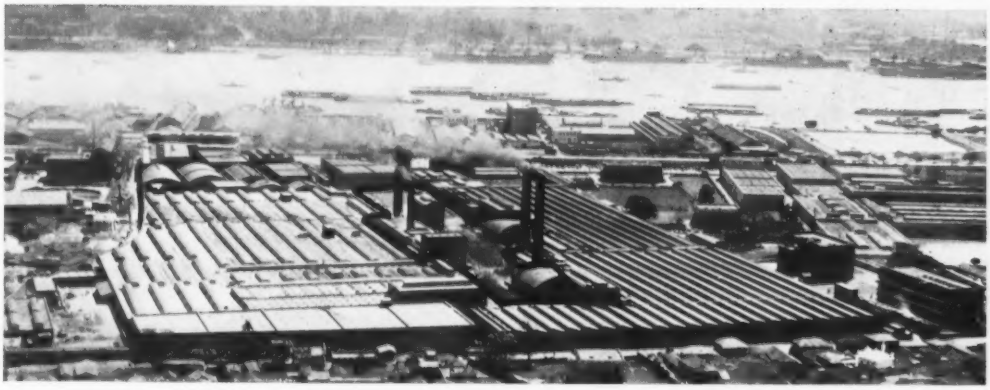


Fig. 1.—The Howrah Jute Mills Conversion to electric driving has set free for extensions the area occupied by the old steam power plant.

Calcutta is no longer the political capital of British India, but it is still India's most important centre of commerce and industry. It owes its importance in this respect to its geographical position as a seaport, and to its proximity to the principal coalfields of India, the jute and tea growing areas, and other sources of natural wealth.

The jute industry has probably contributed more than any other factor to the prosperity of Calcutta, and its importance to India as a whole may be gauged from the fact that exports of jute and jute manufactures have over a very long period of years averaged one quarter of the whole volume of merchandise exported from India. Calcutta is happily situated for obtaining supplies of the fibre. Large areas in Bengal are devoted to the cultivation of the plant, which flourishes in the province as in no other part of the globe. Practically the whole of the jute manufacturing industry of India is concentrated in the mills on the banks of the river Hooghly. The earliest of these mills were built three-quarters of a century ago, and the number has been steadily added to during the years that have elapsed.

Mills built before the commencement of the present century were invariably driven by slow-speed reciprocating steam engines, and to this day these engines survive in many of the mills as the sole source of motive power, although in some cases they have attained the ripe old age of 40 to 50 years. With the advent of cheap electric power, and improvements in the design and manufacture of all kinds of electrical machinery, most of the mills constructed in the last few years have been specially laid out with a view to the electric drive.

The advantages of the electric drive for all kinds of industrial applications, and particularly in textile mills, are now well known and widely recognised, and a large number of the older mills which were formerly driven by steam engines have been re-equipped with electric drive throughout. The application of electric power in some of these cases has been no easy matter, as the layout of the textile machinery and line shafting in the older mills was never arranged with an eye for the requirements of the electric drive.

The economy in running costs due to electrification is utilised to the full only when individual driving of each textile machine is employed. Not all kinds of machinery in textile mills lend themselves equally well to the individual drive, but this type of drive has been applied with success to softeners, spinning frames, looms, etc. The capital cost of an individual motor installation for a large mill is very high,

and it is this consideration more than any other which has restricted the use of the individual motor drive. The majority of new mills driven by electricity are equipped with one driving motor to each of the principal line shafts. The motors may be either direct-coupled to the shafts or may drive through reduction gears or chain transmission, both of which can now be designed for a very high mechanical efficiency. This eliminates entirely the inefficient transmission of power from shaft to shaft by ropes or belts. Clearly, where the whole of the motive power for a large mill is developed in a single mechanical unit, as in mills driven by slow-speed engines, or high-speed turbines with gears, the bulk of the power must be transmitted mechanically to remote shafts, and the rope drive is usually adopted for this purpose. These rope drives are a necessary evil in such cases. They are mechanically inefficient; they require frequent attention and adjustment; and the cost of renewals is high. Actual tests to determine the power lost by friction, rope slip, and windage in large multiple rope drives demonstrate that these losses are remarkably high, and the elimination of this method of driving is one of the most important features of electrification applied to a factory specially laid out for the electric drive.

When, however, it is a case of electrifying an old rope-driven mill it is usually found that limitations of space, and the necessity for effecting the change-over with the absolute minimum loss of production due to shut-downs, make it impossible to instal a motor for each individual line shaft. It is then necessary to some extent to compromise by arranging the line shafts in groups, retaining the already existing rope drives for each group, and installing a large motor to drive each group of shafts.

The Howrah Mills are among the older of the Calcutta jute mills, having been constructed in 1874. They are a group of three mills with a common finishing department, and the total number of looms installed in the whole group is 1,940. In drawing up the plans for electrifying these mills, the foremost consideration was the necessity for effecting the change-over as expeditiously as possible so as to avoid loss of production due to shut-downs. Wherever possible the line shafts are driven by motors either direct-coupled or with chain gearing, but it was found necessary in the case of some of the drives to

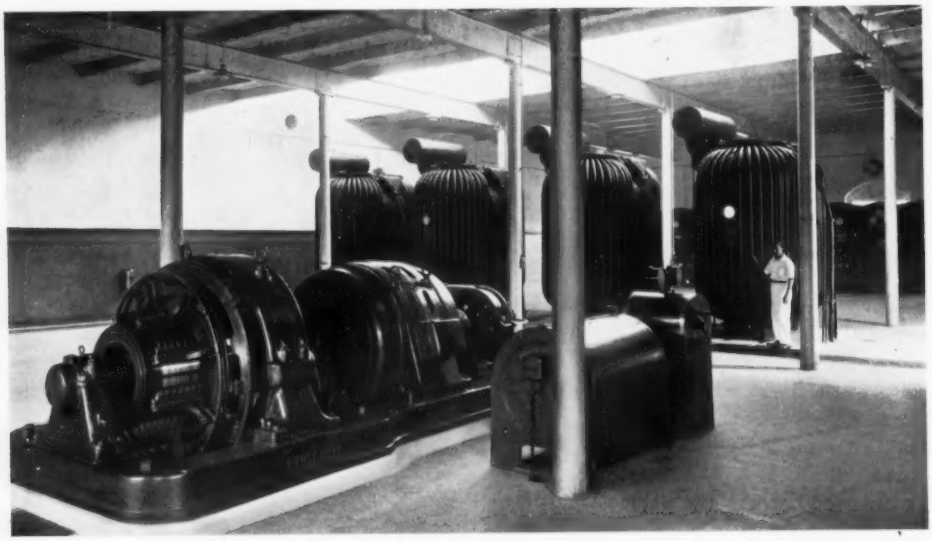


Fig. 2.—The Mills substation contains four 2,000 kVA. transformers and a 300 kW. D.C. generator driven by an asynchronous-synchronous motor.

group the line shafts as described in the last paragraph and retain the old rope drives for transmitting the power from shaft to shaft. The use of rope drives was restricted as far as possible, and only about one quarter of the total horse power is transmitted by ropes. The details of the scheme were drawn up by Mr. J. A. Murray, the Manager of the Mills, and it is a striking tribute to his foresight that the entire change-over to electric drive was effected without any interference with the ordinary working programme of the mills.

Despite the retention of some of the rope drives, the benefits derived by this Company from electrification are striking in the extreme. In the first place the clearance of ground due to demolition of old boiler houses, engine rooms, chimneys, etc., and the filling in of a settling tank, has set free sufficient space for the construction of another complete 700 loom mill, should conditions at any time be such as to warrant the laying down of another mill. This is a factor of great importance to the Howrah Mills Co., whose mills are situated in a congested urban locality affording no facilities for extension such as are enjoyed by some of the mills in the outlying areas to the north and south of Calcutta.

Other benefits consequent upon the electrification of these mills consist in a notable reduction in working expenses, and an improvement in production. The gain in production results from a marked diminution in the number of breakages of yarn during the spinning process. Thanks to the very even turning moment exerted by electric motors, these breakages of yarn are much less frequent than with the old drive by reciprocating engine.

Taking advantage of cheap rates offered by the Calcutta Electric Supply Corporation, the Howrah Mills Co. decided to take bulk supply from the Corporation in preference to generating their own requirements in a power house at the mills. Power is supplied to the mills from the Calcutta mains at 6,000 volts, 3-phase, 50 cycles. A transformer substation was erected in a convenient position and contains four transformers, each for an output of 2,000 kVA. stepping down the incoming supply voltage to 3,300 volts for distribution to the motors in the mills. For supplying a number of direct current auxiliaries, as well as D.C. fans and lighting, a 300-kW. 220-volt motor-generator set is also installed in the substation, the driving motor being of the synchronous induction type working at unity power factor. The substation is illustrated in Fig. 2.

Fig. 3.—Heavy rupturing-capacity Truck Switchboard controlling 6000-volt supply.

The transformers have the usual tappings to provide against variation in the supply voltage. They are of the oil-immersed self-cooled type with external cooling tubes and each transformer has an expansion vessel and chloride breather, and a dial type thermometer. The windings are connected delta-star and the secondary neutral is brought out for earthing. A special cubicle is mounted close to the transformers, and contains an arrangement of interlocked isolating links such that it is not possible to earth the neutral points of more than one transformer at any time.

A reference should here be made to the switchgear installed in the substation by the Calcutta Electric Supply Corporation for the control of their incoming feeders and for metering the supply to the mills. This switchgear is of the English Electric Co.'s heavy rupturing capacity draw-out truck type and the board is shown in Fig. 3. Owing to the magnitude of the installation and its proximity to the Southern Generating Station on the opposite bank of the river, the Supply Corporation considered it necessary to instal switchgear of more robust proportions than that which they commonly use on consumers' premises. They specified a rupturing capacity of 150,000 kVA, but the gear installed has a safe rupturing capacity of 250,000 kVA. The clearances provided throughout in this switchgear are such as are standard for 13,000 volt systems, so that on the Calcutta system it affords a large margin of safety. The movable trucks run on wheels fitted with ball bearings, so that in spite of their size and weight they are extremely easy to manipulate. The switchgear has all the interlocking features customary in truck-type gear, and is so designed as to be completely vermin-proof.

The main distribution switchboards in the substation, Fig. 4, both 6,000 volts and 3,300 volts, are of the sheet-steel cubicle type with front panels of polished black slate on which are mounted the various instruments, and the operating mechanism for the circuit-breakers.

The substation building is of ample dimensions, to allow room for any future extensions, and to ensure adequate lighting and ventilation.

The mill motors number twenty-six in all, and the total horsepower installed is approximately 7,000 h.p. There are six sizes of motor only, viz., 1,100 h.p., 550 h.p., 330 h.p., 220 h.p., 100 h.p., and 50 h.p. The eight motors of 330 h.p. and upwards are of the English Electric Co.'s well-known synchronous induction type which combine the good starting characteristics of the ordinary slipring induction motor with that property of synchronous machines which enables them to run at unity or leading power factor by suitably regulating the excitation

Fig. 4.—Main Distribution Switchboards for 6,000 volts and 3,300 volts.

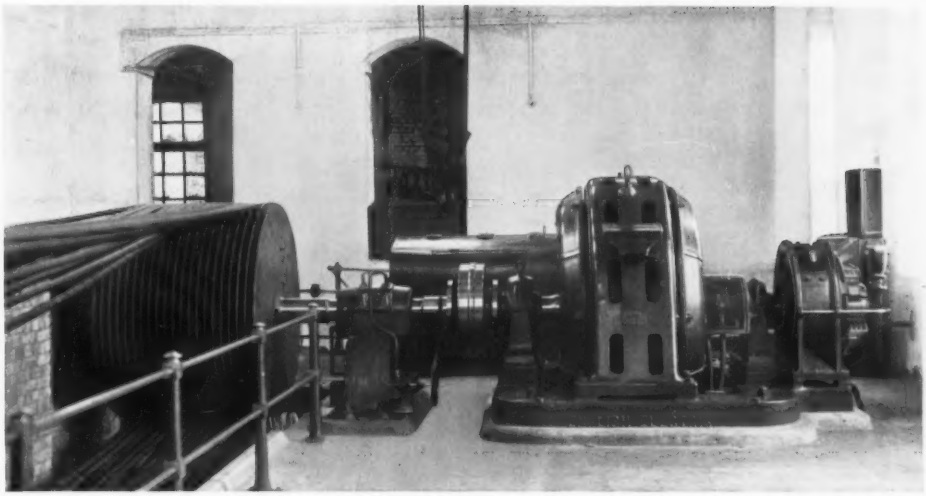


Fig. 5.—1,100 H.P. Asynchronous-synchronous Motor in No 2. Mill.

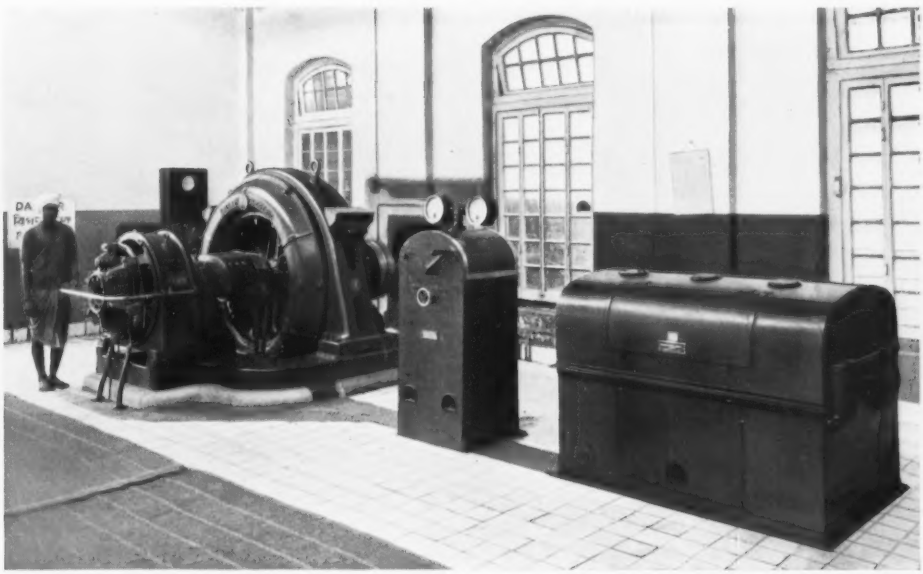


Fig. 6.—550 H.P. Asynchronous-synchronous Motor and Control Gear in No. 3 Mill.

current. All the remaining mill motors are of the slipring induction type.

The synchronous induction motors were designed to correct the power factor of the installation as a whole to the extent of maintaining unity power factor on the 6,000-volt busbars in the substation with all the mill motors working at full load. This purpose has been successfully fulfilled, and unity power factor is maintained on the E.H.T. busbars at all loads up to full load. This is a matter of the greatest importance to the Howrah Mills Co. The Calcutta Electric Supply Corporation offer very tempting inducements to power consumers on their system to maintain a good power factor, by allowing a substantial rebate per unit consumed, which increases progressively according to the amount by which the consumer's power factor exceeds 85 per cent. There is a corresponding penalty in cases where the power factor falls below 80 per cent. On a normal year's working the rebate earned by the synchronous-induction motors at the Howrah Mills amounts to about Rs. 25,000—say £2,000. This annual saving is approximately equivalent to the extra capital cost which was incurred by installing motors of the synchronous induction type instead of ordinary induction motors, so that the extra capital outlay is fully recovered in about one year. There can be no doubts as to the economic soundness of this proposition.

Except for a few of the smallest machines all the motors are housed in special motor houses outside the mill, and work in surroundings free from the dust and fluff with which the air inside a jute mill is always laden. It thus becomes an easy matter, with periodic attention, to keep the motors clean and the ventilating ducts free from obstruction. In the hot climate of Calcutta (the air temperature in the motor houses sometimes exceeds 120° F.) it is a matter of great importance to ensure an unimpeded flow of ventilating air through the machines. Failing this, trouble must be expected from overheating and "hot spots."

Five motors—two of 1,100 h.p., and three of 550 h.p.—are direct-coupled to driven shafts running at 300 r.p.m. by means of Wellman Bibby flexible couplings. Examples of the large motor drives are shown in Figures 5 and 6. The remainder of the motors are high-speed machines, and the necessary speed reduction is effected by means of Hans Renold silent inverted-tooth type chain drives. The driving pinions are keyed on to separate jack-shafts, which are supported by two pedestal type roller bearings, and coupled to the motor shafts by Wellman-Bibby flexible couplings.

The smaller motors have ordinary grease-lubricated roller bearings, but on the motors of 330 b.h.p. and upwards a novel type of "controlled return feed" oil-lubricated roller bearing is employed. The oil circulation depends upon the same principle as is used in oil-ring lubricated bearings, but the rollers are made to act as a pump instead of using a ring. Assembly and inspection is easier than with sleeve bearings, friction is reduced to a minimum, and as there is no wear of journals the rotor remains concentric

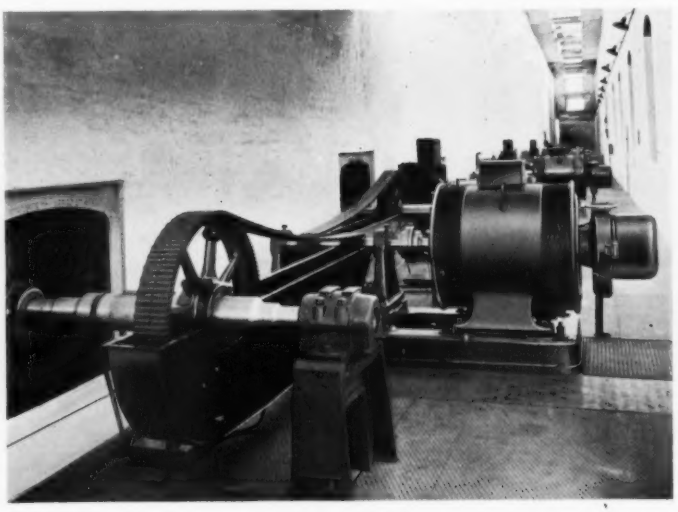


Fig. 7.—100 H.P. Motors in No. 1 Mill Weaving Department each with chain drives to two lineshafts.

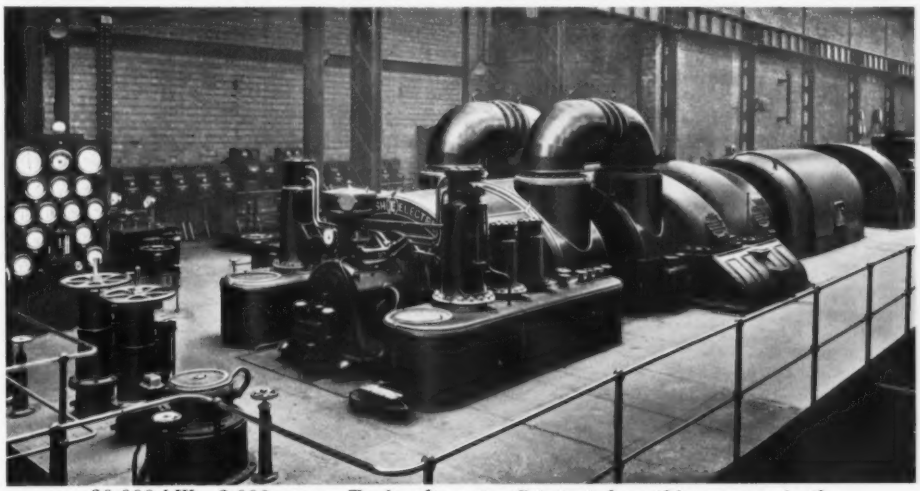
with the air-gap. These bearings require a very light grade oil, but if this point is attended to and the correct oil level is maintained, and if the bearings are occasionally washed out and supplied with fresh oil, they will be found extremely reliable in service, and they represent a marked advance on the use of sleeve bearings for large electric motors.

The weaving departments in No. 1 and No. 3 Mills are driven by means of a number of motors, each of 100 h.p. Each motor drives a pair of line-shafts, one on either side, by means of Hans Renold chains. These motors are installed in alleyways, outside the mills, which were formerly used as rope alleys; an example of one of these alleyways is shown in Fig. 7. Continuous platforms of chequer plating carried on steelwork supporting structures run the length of the alleyways, and afford ready and convenient access to all the motors and chain drives.

The smallest motors in the installation are four of 50 h.p., each of which drives an 8-barrel hydraulic press-pump through Renold chain gearing. These motors are wound for low tension supply at 400 volts, 3-phase, 50 cycles, and a 200 kVA transformer is installed for this purpose; the transformer is accommodated in an adjacent motor house, containing a 220 h.p. motor, which drives the finishing machinery (calenders, etc.).

A notable feature of the press pump drives is the operation by means of automatic controllers, having a series of contactors controlled by solenoids which start up the motors step by step, the whole operation being accurately timed. The equipment is controlled by a master switch conveniently placed close to the motor, and consisting of a pair of push button switches marked "Start" and "Stop." After depressing the "Start" button the whole of the starting operations are carried out automatically. This apparatus enables the motors to be started and stopped as quickly as possible, without overloading and without the need of skill on the part of the operator. Press pump motors require to be started and stopped at very frequent intervals, and it has been found by experience that the small extra cost of the automatically controlled gear is quickly repaid by the improved production which results.

The English Electric Company, were main contractors for the whole of the substation and mill equipment and were responsible for carrying out the complete installation.



30,000 kW., 3,000 r.p.m. Turbo-alternator Set started up this summer in the Thornhill Station of the Yorkshire Electric Power Company.

The De-ionising Method of Arc Control.

Circuit Breaker Development.

For many years circuit-breaker design has followed, with few changes, except in detail, the orthodox procedure of separating contacts under oil, and there has been little or no understanding of the problem of controlling the arc set up during the parting of the contacts. More recently, it became better understood that the whole circuit-breaker is stressed in proportion to the arc energy dissipated in the tank, and these stresses were met, when necessary, by strengthening the tanks, top plates, and other parts to withstand the pressures developed, but no consideration was given to bringing the arc under control.

The latest research and experience has shown that steel tanks and top plates, even when reinforced by ribs or webs, are not always effective in preventing the failure of circuit-breakers due to explosion, fire or other causes. It has been confirmed also that merely to change arbitrarily the operating or mechanical characteristics such as contact speed or travel, head of oil, etc., may lead to less satisfactory operation instead of providing a cure for such failures. It has been shown that for a given design of circuit-breaker the pressure rise within the tank is a function of the arc energy liberated, and, finally, means have been discovered for controlling the quantity of arc energy.

With this new insight into the subject the design of circuit-breakers, more particularly in relation to arc control, was given over to research engineers for investigation of the best method of controlling the cause of pressure rise, that is to say, the arc itself. At the same time the area of enquiry was extended to embrace the valuable experience of users and manufacturers in other parts of the world in dealing with breakers controlling large amounts of power, and it was possible to obtain the co-operation of those who had at their disposal experimental laboratories capable of testing out the new ideas and developments which arose in the course of the research work.

As a consequence of the attention that has been given to these problems, the English Electric Company is now able to incorporate in its circuit-breakers the De-ion contact described in this article.

General Principle of De-ion Contact.

It is well understood that when circuit-breaker contacts separate, the space between them becomes highly ionised, and an arc is produced which vaporises the insulating medium, thereby weakening its insulating value to such an extent that the arc can persist with a comparatively low voltage. In considering the best means of

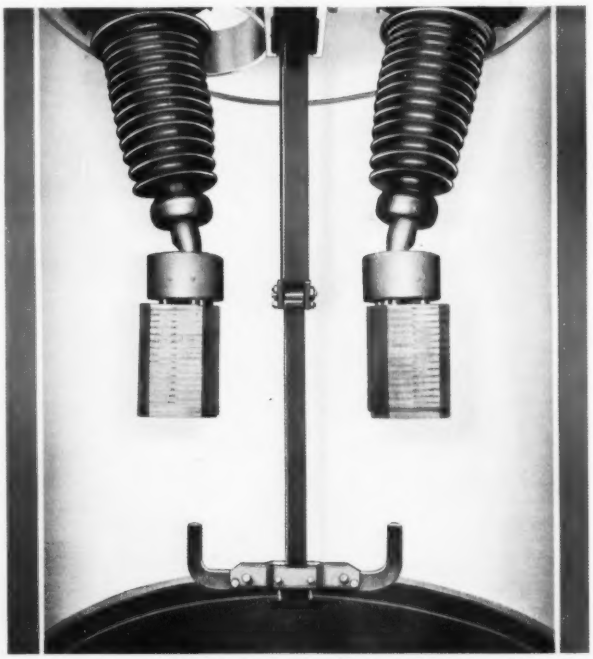


Fig. 1.—Single-pole Circuit-breaker fitted with De-ion Contacts.

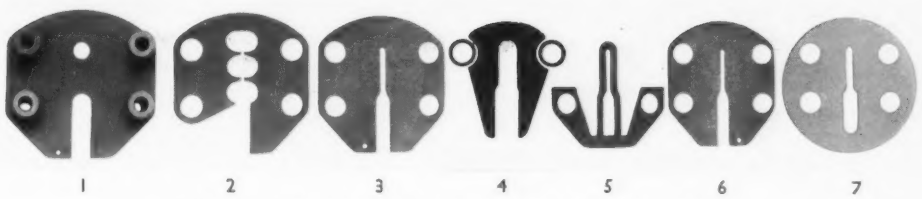


Fig. 2.—Typical Group of Elements for section of a De-ion Stack.

extinguishing the arc, it has to be realised that it is difficult to force a jet of oil into an arc because the arc, being very mobile and of negligible mass, has a tendency to be deflected, while the oil, on the other hand, having appreciable mass, is difficult to move quickly. Therefore, the more logical plan is to reverse this process and to devise an arrangement whereby the arc is forced into contact with the oil.

The De-ion contact acts upon the arc from the moment it is formed, forcing it into contact with oil which cannot readily escape, while the gases produced are used to de-ionise the arc system. In addition, the De-ion method of control continues to attack the arc along its entire length right up to the time of final extinction.

Construction of De-ion Contact.

Figure 1 shows a De-ion stack mounted on each of the fixed contacts on a circuit-breaker, with the moving contact bar of the circuit-breaker in the open position.

Figure 2 shows the various elements of a single section of a De-ion stack arranged in the order of their assembly. The number of sections used in a complete stack for one fixed contact is determined by the working voltage of the breaker.

In Figure 3 is shown a number of De-ion stacks for use on circuit-breakers designed for pressures of 132 kV. down to 11 kV. These views illustrate the laminated structure of the assembled stack consisting of insulation elements, magnetic elements and oil pocket elements, each having slotted openings which register to form a deep and relatively narrow groove, through which the arc is drawn by the moving of the contact bar. The oil is held within the structure by means of the oil pockets in such a way that it cannot readily escape. Substantial plates at the top and bottom and insulated assembly bolts hold the complete unit rigidly together. The complete stacks are impregnated with oil to prevent absorption of moisture while in transit or in store before being placed in service.

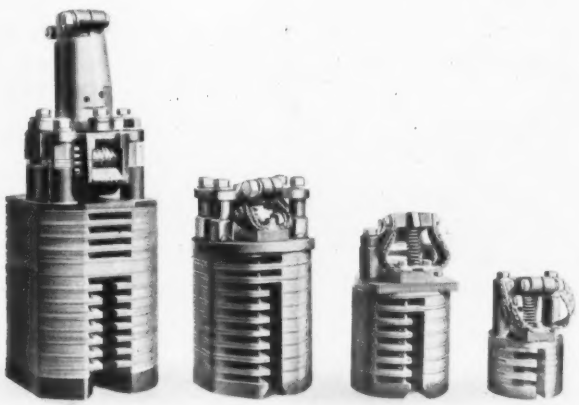


Fig. 3.—De-ion Stacks for pressures of 132 kV to 11 kV.

Theory of De-ion Contact.

The extinction of an alternating-current arc is principally dependent on two factors :—

(1) The rate at which the arc space recovers its dielectric strength after the current ceases to flow at the zero point of the wave.

(2) The rate at which the voltage applied to the arc

terminals by the external circuit builds up, this factor being determined largely by the circuit characteristics.

The De-ionising method of arc control aims at speeding up the recovery of dielectric stress in the arc space. When the sparking contacts separate, an arc is formed between them, vaporising the confined oil in the immediate vicinity. The vaporised oil can only escape by passing through the arc stream, and this produces violent turbulence in the arc space, breaking up the arc stream into numerous smaller streams and tending to keep the degree of ionisation uniform throughout the arc space.

Upon the current falling to zero the arc is extinguished and the production of ions ceases, but de-ionisation due to recombination and direct loss continues, the whole process being much accelerated by the uniform state of ionisation in the space previously occupied by the arc. Consequently, the insulation value of the space between the contacts very quickly rises to its maximum.

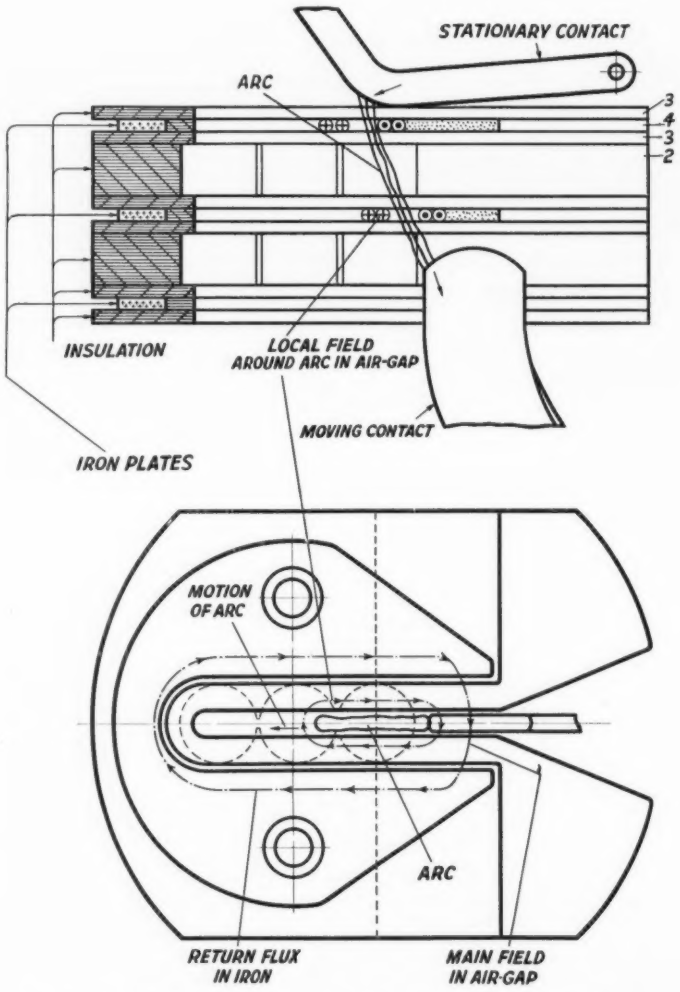


Fig. 4.—Diagram showing the relation of the parts of the De-ion Contact to the Arc.

It will be understood, therefore, that this method of arc control is continuous until the arc is finally extinguished. Normally, arc extinction will occur in the upper sections of the De-ion stack, the extra lower sections being to provide the safety factor that is essential in a device such as an E.H.T. circuit-breaker.

Figure 4 shows diagrammatically the relationship between the arc and the component parts of the De-ion contacts. On opening the breaker, the contacts separate and an arc is drawn between the stationary and moving contacts in the slot of the De-ion stack. As the contact bar moves downwards towards the fully open position the arc is drawn through the air gap of the iron plates, and these plates are magnetised so as to produce a magnetic field across the gap. During the further downward motion of the moving contact the arc is drawn across the field of each succeeding magnetic plate and the magneto-motive

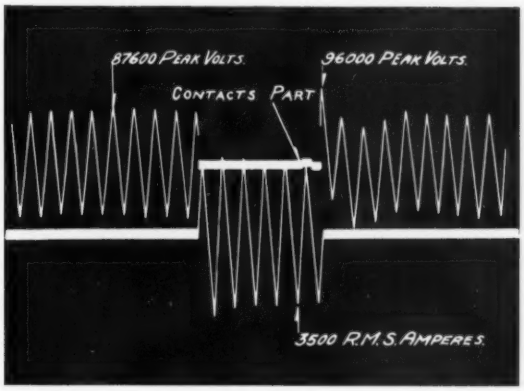


Fig. 5.—Test on 110 kV Breaker fitted with De-ion Contacts.

forces across the air gaps act in such a manner as to force the arc towards the closed side of the slot. The magnetic sections of each stack are interleaved with groups of plates shaped in such a way as to form oil reservoirs which hold a considerable quantity of cool, fresh oil, with which the arc is maintained in contact. These oil pockets are divided into several compartments separated from each other by closely restricted passages, which ensure that sufficient oil is retained until the de-ionising process is complete.

Experience and Tests.

Experience under practical conditions has shown that the "De-ion contact" circuit-breaker reduces the arcing time, and to an even greater extent reduces the arc energy more than any other type of contact that is known.

Figures 5 and 6 show two oscillograms of tests carried out on a 110 kV. 60-cycle system of a large power supply company. The upper oscillogram relates to a circuit-breaker equipped with De-ion contacts when breaking 3,500 amperes on a 110 kV. circuit; rupture was completed in one cycle of arcing with 136 kW.-seconds of arc energy. The result obtained with the same circuit-breaker without De-ion contacts is shown in the lower oscillogram, from which it is seen that when breaking 3,480 amperes at 110 kV. the period of arcing was 13 cycles, and the arc energy liberated was 2,470 kW.-seconds. Hence, for this particular test, a criterion of the relative merits of ordinary contacts and De-ion contacts is given by a ratio of arcing time amounting to 13 to 1, and a ratio of arc energy amounting to 20 to 1.

Evidence of a still more striking character is given by Figures 7 and 8. Figure 7 is the record of a large number of tests for arcing times carried out on a breaker without De-ion contacts and when fitted with De-ion contacts. Figure 8 is a record of the arc energy during the same tests. The scattered positions of the points when ordinary contacts are used shows very clearly the lack of control of the arc, and is in distinct contrast to the close grouping of the points on the curves for the breaker fitted with De-ion contacts. When a breaker with ordinary contacts has operated twice under short-circuit conditions it is desirable to remove the breaker from service, whatever its design, and inspect it as soon as possible to determine what maintenance work is necessary. This is not necessary with circuit-breakers fitted with De-ion contacts.

The oil in a breaker fitted with De-ion contacts undergoes far less carbonisation than in a breaker with ordinary contacts, with the result that for a

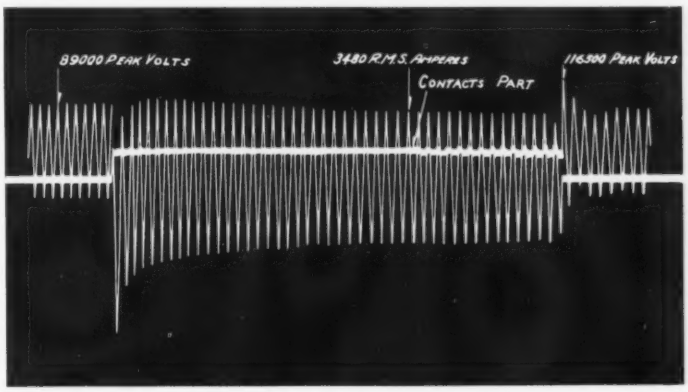


Fig 6.—Test on 110 kV. Breaker fitted with ordinary contacts.

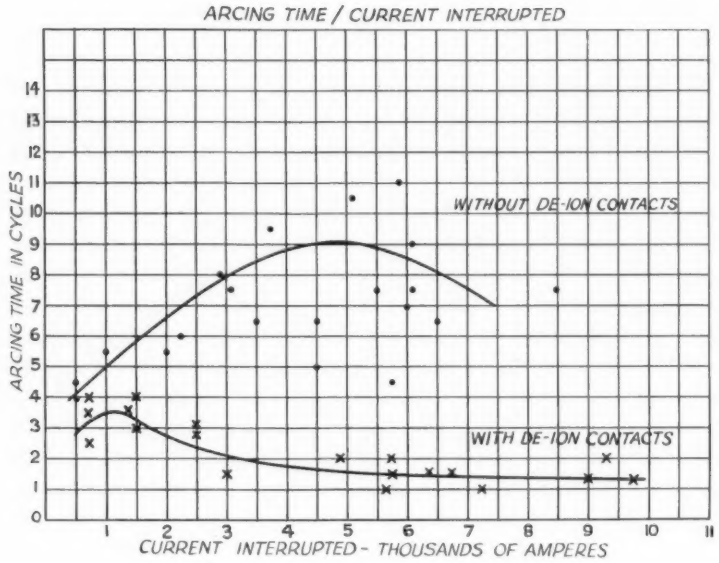

ARCING TIME / CURRENT INTERRUPTED
ARCING TIME IN CYCLES
WITHOUT DE-ION CONTACTS
WITH DE-ION CONTACTS
CURRENT INTERRUPTED - THOUSANDS OF AMPERES

Fig. 7.

Record of tests on circuit-breaker when fitted with ordinary contacts and with De-ion Contacts.

ARCING-TIME.

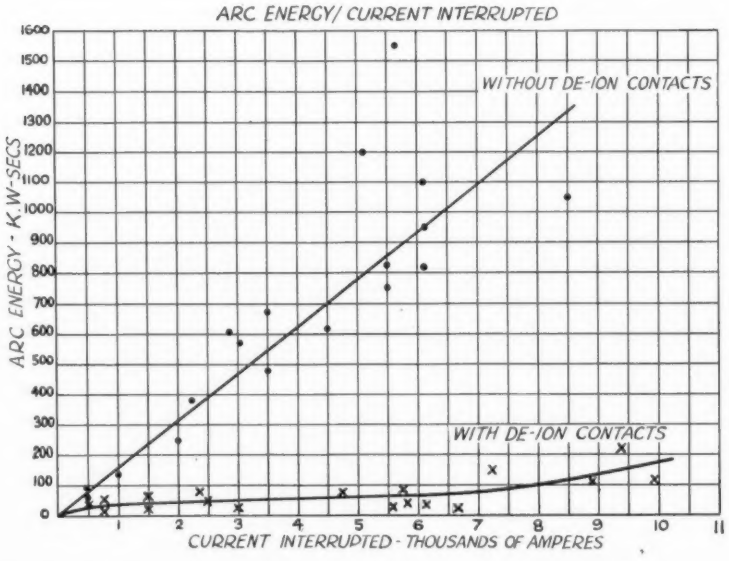

ARC ENERGY/ CURRENT INTERRUPTED
ARC ENERGY - K.W-SECS
WITHOUT DE-ION CONTACTS
WITH DE-ION CONTACTS
CURRENT INTERRUPTED - THOUSANDS OF AMPERES

Fig. 8.

Record of tests on circuit-breaker when fitted with ordinary contacts and with De-ion Contacts.

ARC-ENERGY.

given number of circuit interruptions under short-circuit conditions the oil in a De-ion breaker requires far less filtering or changing. There is, consequently, a further saving in maintenance costs. These improved operating characteristics are due to the definite control of the arc and the method used for its extinction in the De-ion contact.

SUMMARY.

The principal advantages gained by the use of De-ion contacts may be summarised as follows :—

(*a*) The arc is controlled so that the energy to be dissipated is reduced to a minimum.

(*b*) The arc is interrupted at the earliest possible moment consistent with the safety of the system.

(*c*) The De-ion contact acts upon the arc immediately it is formed, and continues its attack so long as the arc persists.

(*d*) The arc is forced into and maintained in contact with fresh, clean oil.

(*e*) As the contact bar moves downwards and the arc lengthens, additional de-ionising chambers come into action automatically.

(*f*) Oil depreciation is a minimum, making unnecessary frequent handling of large quantities of oil.

(*g*) The renewable arcing parts are inexpensive and easily replaced when necessary.

(*h*) The tanks and mechanical parts of the breaker can be earthed.

(*k*) No auxiliary apparatus required.

(*l*) Can be fitted to existing " English Electric " circuit-breakers.

APPLICATION.

De-ion contacts can be fitted to nearly all designs of " English Electric " oil circuit-breakers.

De-ion contacts are available for low-current breakers usually associated with the higher voltages for outdoor situations, while other sizes are suitable for breakers for the higher currents and lower voltages associated with power station work.

" English Electric " specialists are anxious to discuss in detail with clients the advantages, construction and theory of the De-ion contact and to make recommendations for the application of what has been shown to be the most scientific and satisfactory method of interrupting extra-high-voltage power currents.

"English Electric" Bodies for Petrol Buses.

It is doubtful whether there is any other factory that is so widely known to Tramway Engineers all over the world as the Preston Works of the Company, which was for so many years connected with the names of Dick, Kerr & Co., and their Associates, the United Electric Car Company. For over thirty years this Works has specialised in the designing and construction of tramcars and electrical equipments for them, and the study of current transport requirements is carried on to-day just as actively as at any time during its history. From its close contact with Public Transport Authorities all over the world, the Company is satisfied that with proper adaptation to present-day needs the tramcar can still occupy an important place in providing economic transport under certain conditions. In conjunction with Tramway Engineers in many countries, great improvements have been developed at Preston, both in the passenger accommodation and the electrical and mechanical equipment, and their modern tramcars, designed to meet the particular local conditions, are as different from the older vehicles as the modern omnibus is from the old horse drawn vehicle.

Side by side with this development the Company has given much attention to the perfecting of the alternative electric passenger vehicle, the trolley bus, and in addition has utilised its long experience and very complete equipment for the

Fig. 1. Ten double-deck and four single-deck buses for Preston Corporation.

production of petrol bus-bodies of the highest class. Its experience in the requirements and technique of road vehicle construction has ensured from the outset that " English Electric " bus bodies would rank high in the estimation of operating companies, and the makers of petrol bus chassis. Sufficient proof of this is afforded by the vehicles illustrated in this article, which have all been supplied during the past few months and include a large proportion of repeat orders.

The fleet illustrated in Figure 1 consists of ten double-deck and four single-deck buses recently delivered to the Preston Corporation. The double-deck top covered vehicles have a seating capacity of 53, 24 downstairs, and 29 upstairs ; and have a low-loading platform from which a staircase, specially designed for easy mounting, leads to the top deck ; a low step leads into the lower saloon. The comfort of passengers has been carefully studied, and special features are the well-sprung seats upholstered in real hide, the ample spacing between seats, and the provision of head room in both decks that is in excess of the regulation height. The single-deck buses seat 32 passengers, and the saloon is divided into smoking and non-smoking compartments ; the details of the seating are similar to those of the double-deck buses. The entrance at the rear end is fitted with a folding door, and there is an emergency exit near the front end on the off side. Both types of bus have been granted certificates of fitness by the North-Western Area Traffic Commissioners, and it is understood that since the fleet has been put into service marked appreciation has been shown of the high standard of comfort which they afford.

An interesting development in bus-body work is shown in Figure 2 and the lower figure of the frontispiece illustrating bus-bodies recently put into service by the Wallasey and Bournemouth Corporations respectively. Both these vehicles are provided with front and rear staircases to the upper saloon, and it will be remembered that this was a feature of the bus exhibited on the "English Electric" stand at the Commercial Motor Transport Exhibition last year. The object of this arrangement is to effect speedy loading and unloading. The rear staircase which leads to the upper saloon from the rear platform is used as an entrance only, the exit being by the front staircase, and a front exit on the

Fig. 2. One of six vehicles for Wallasey Corporation.

Fig. 3.

One of the latest vehicles for Hull Corporation; part of an order for 20 bodies following an earlier order for 15.

Fig. 4.

For Halifax Corporation, 3 double-deck and 6 single-deck bodies.

Fig. 5.

4 double-deck bodies have been supplied to Blackpool Corporation.

nearside of the lower saloon. The buses may aptly be called one-way buses, as the passengers move in one direction only through the vehicles, and there is no time lost while incoming passengers wait for outgoing passengers to alight.

Wallasey Corporation recently put into operation 6 of these vehicles, and have placed a repeat order for 3 more. Bournemouth Corporation have put six vehicles of this type on the road.

These bodies have been built to the special requirements of the users, and embody several interesting features. The doors of the exit on the nearside are under the control of the driver, so that in slack periods this door can be kept closed, and the bus run with the rear entrance only available. Further, the control that the driver has over this door provides an additional safeguard to the public, in ensuring their exit only when the bus has come to a standstill.

Reports received from both towns indicate that the one-way system is popular, and assists considerably in reducing the time taken at stopping places during the busy periods.

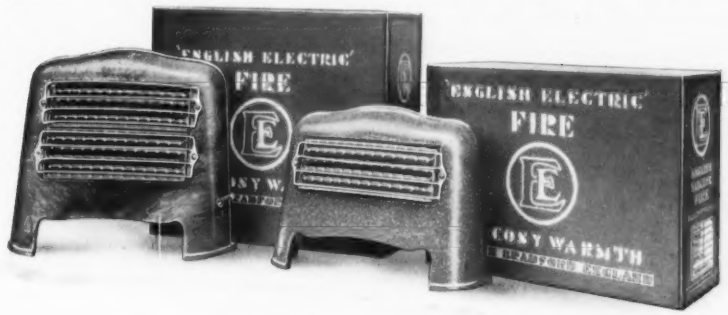
Figure 3 illustrates one of the latest vehicles for Hull Corporation, being one of an order for 20, which followed on an earlier order for 15.

Portsmouth Corporation have just received the last of 20 bus-bodies illustrated in Figure 5, which makes a total of 46 bodies supplied to this system. Some of these vehicles are illustrated in the centre view of the frontispiece.

Other recent orders are :—3 for Northampton Corporation ; 12 for Halifax Corporation, 4 for Blackpool Corporation ; these are illustrated in the frontispiece and Figures 4 and 5 respectively.

New Tramcars for Calcutta.—*The Calcutta Tramways Company have adopted thoroughly modern designs for their latest vehicles. This is a two-car articulated unit equipped and tested at Preston Works.*

"English Electric" Fires for 1932-33 Season.



Each Fire is packed in a carton for easy storage and transport.

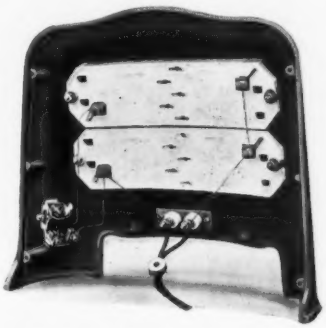
"English Electric" fires are manufactured at the Bradford Works of the Company, and are of British manufacture throughout. The high standard of value which they represent has only been obtainable by producing them in very large quantities by the most modern methods.

The shape of the casing has been kept as simple as possible in accord with modern taste, and conforms very well with almost any type of decoration. The smooth and simple form has the further advantage that the surface can be kept clean very easily. A valuable feature is the provision of a close-fitting stove-enamelled metal sheet over the back of the fire in order to prevent the chimney effect which causes dust to be drawn across the element and afterwards deposited on surrounding objects.

The castings, which are produced in the Company's Bradford Foundry by the most modern methods, have an excellent finish and are coated with permanent vitreous enamel. Although strong enough to meet all normal requirements the castings are light, and the two sizes of fire weigh only 9 lb. and 15 lb. respectively.

Each fire is despatched in a separate carton which provides ample protection for transit by road or by passenger train.

Elaborate attention has been given to every detail of construction. Not only is the best material obtainable employed for the fire-clay forma and the heating wire, but the methods of assembly ensure a very long life without attention or replacement. The spirals of the heating wire are in one continuous length in each element, and are anchored sufficiently to prevent sagging or displacement. Where the wire passes from one spiral to the next above or below it, a short straight length is substituted in order to prevent local overheating at these points; the short straight pieces are anchored in position. The anchors are of non-corrodible metals, as also are the terminals to which the ends of the heating wire are taken, and the connections from each element to the main terminals are of pure nickel wire, which is practically unaffected by heat.



Back of a 2 KW. Fire without Cover plate.

2 KW. Fire in Shaded Finish.

Electric Power in a Model Dairy Farm.

Fig. 1.—General view of Milborne Central Dairy.

(By the courtesy of Sir Ernest R. Debenham, Bart., we are able to describe the electric supply system of the Bladen Estate, in Dorsetshire, and the installation at the Milborne Dairy, which, as regards completeness and the model character of its equipment, is probably unique in this country. We are indebted to the Managing Director of Bladen Dairies, Ltd., Mr. H. W. S. Palmer, Mr. H. V. M. Pollock, Manager, and the Consulting Engineer, Mr. J. Harrington, M.I.E.E., A.M.I.Mech.E., for assistance in preparing this article.—ED.)

The underlying ideas that prompted Sir Ernest Debenham to promote this enterprise are best indicated in his own words :—

> " The Bladen Estate Farms should be considered as an experiment, initiated with the chief object of ascertaining whether, under modern conditions, and with the resources and facilities supplied to agriculture by recent scientific discoveries, it is possible for Dorset (and inferentially for Great Britain as a whole) to produce a larger proportion of home-grown foods, especially of animal origin, than it does at present. That it should do so would probably be generally admitted to be desirable, since it would readjust the balance of population and enable a larger number of workers to live on the land.
>
> " It was felt that the best practical way to approach this very difficult problem was by organising in one particular area and on land not of the best quality, a large demonstration farm which might ultimately be of use in many ways to the neighbouring farms, and would in itself have exceptional means for dealing internally with its own produce and feeding stuffs.
>
> " Among the benefits which such a central demonstration farm of a size up to 10,000 acres might confer upon the surrounding area are facilities for marketing, transport, and modern scientific information, which might increase the profits to the farmer and do away with the need for some, at any rate, of the customary distributors and intermediaries. With this object a portion of the Bladen Farms is being run on thoroughly intensive lines, and it is hoped and believed that, with time and experience, the experiment may justify itself."

Milborne St. Andrew, near which the central dairy is situated, is eight miles from Blandford. The estate comprises a large number of separate farms, which have been allocated as dairy farms

of more or less standard capacities, sheep and poultry farms and piggeries. All are conducted on strictly commercial lines with modern scientific equipment, and full records are kept of the history and results obtained from individual animals.

The Milborne Central Dairy, illustrated in Fig. 1 and to which detailed reference will be made later, is a self-contained factory having a capacity of 30,000 gallons of milk per day, and includes not only the necessary equipment for the production of cheese and butter, but also machinery for the manufacture of the special sealed cartons, which are the only form of container used for the delivery of the fresh pasteurised milk.

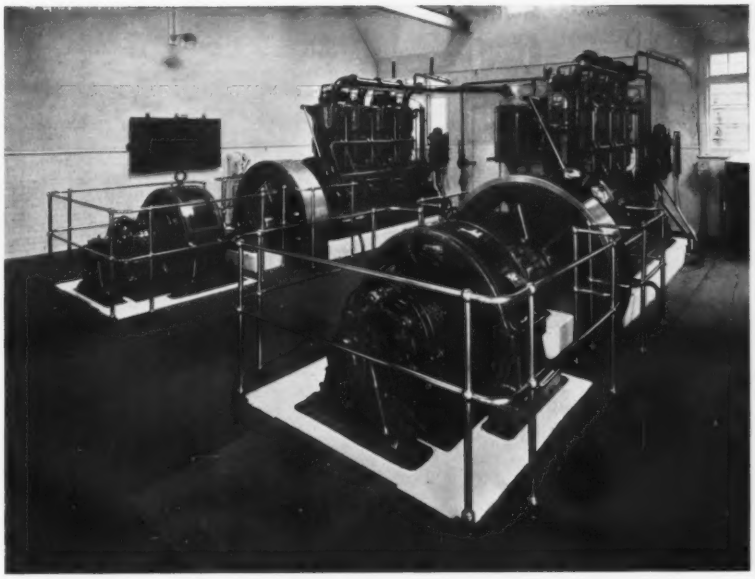


Fig. 2.—Power House at Briant's Puddle.

Electric power is used for lighting, heating and practically all power purposes throughout the estate, and is supplied from two power houses at Briant's Puddle and Milborne respectively. The southern portion of the estate was the first to be developed, and when the question of electric power was being considered it was not contemplated that an additional area of nearly twice the acreage would subsequently be brought into the scheme. The alternative methods considered at that date for the most economical supply over the comparatively large area were A.C. high tension transmission, direct current at 250 volts, and small independent generating sets supplying groups of farms. It was found that the capital cost of high tension transmission would have been very high in view of the necessity of complying with the regulations then in force, many of which have been much modified during the past two or three years. The final decision was in favour of a central station for the area, generating direct current at 250 volts, the highest pressure permissible for ordinary domestic applications such as lighting and heating. It should be explained that at that time there was no prospect whatever of a public supply of electric power being available at any point within practicable reach of the estate.

The original scheme of distribution provided for three main feeders from the Briant's Puddle Central Station, of which No. 1 runs to Turners Puddle, a distance of about one mile, with a branch from Throop to a proposed new dairy; No. 2 to East farm and West farm, a total distance of about $1\frac{1}{4}$ miles; and No. 3 to Rogers farm, at a distance of $1\frac{1}{2}$ miles. The power house and pump house are constructed with steel frameworks and concrete block walls; the former is subdivided into an engine room, Fig. 2, and a switch room, and contains two 120 H.P. oil engines driving 80 kW. " English Electric " generators at 350 r.p.m., together with booster sets for the individual feeders. In the switch room there is a main switchboard having three generator panels, a battery panel, two small power panels, and one panel for controlling local lighting. In

addition, there is a booster switchboard of six sections, each of which controls a booster and two farms. A small storage battery is installed for lighting purposes during the night, when the power station plant is shut down.

Current is transmitted by overhead lines in most cases, and the supply is used for lighting the dairies and residences and for the pumps, milking machinery, refrigerating plant, water heating apparatus and mechanic shops on the various farms.

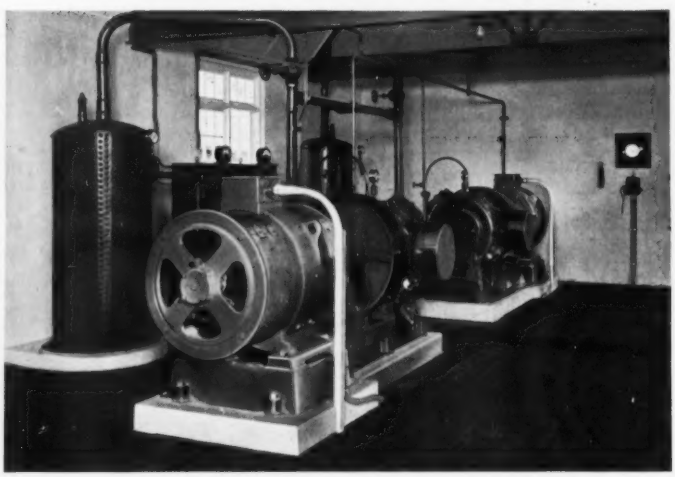


Fig. 3.—Air Compressors for Water Supply at Cole's Farm.

Water is obtained from a 24-inch borehole sunk 231 ft. into the chalk, and is pumped into a reservoir having a capacity of 80,000 gallons by three three-throw pumps, each driven by a 24 H.P. motor through worm reduction gear. In the pump house there are also two centrifugal pumps driven by 11 H.P. motors for supplying other reservoirs to the north and south of the pump house, about a mile distant. The average daily water consumption at this end of the estate is about 52,000 gallons.

Fig. 4.—Cole's Farm Pump House.

When the northern end of the estate was acquired and the erection of the Milborne Dairy was decided upon, it was apparent that a new power house and water supply would have to be provided. The site chosen for the power house was adjacent to the dairy buildings, but it was found that water could be obtained more advantageously at Cole's farm in conjunction with a reservoir at Lawn Barn. In this case a 30-inch borehole was sunk to a depth of 400 ft., and a supply of water of excellent quality is obtained. The quantity taken from the borehole is about one million gallons per week. The water is lifted by means of air compressors (Fig. 3) driven by 45 H.P. 500-volt motors and pumped to a local reservoir of 70,000 gallons capacity. Three-throw pumps driven by 24 H.P. 500-volt motors are also installed here for delivering water to the Lawn Barn reservoir, which has a capacity of 180,000 gallons, and is situated at such a level as to give an adequate gravity feed over a considerable area. The pumping plant, illustrated

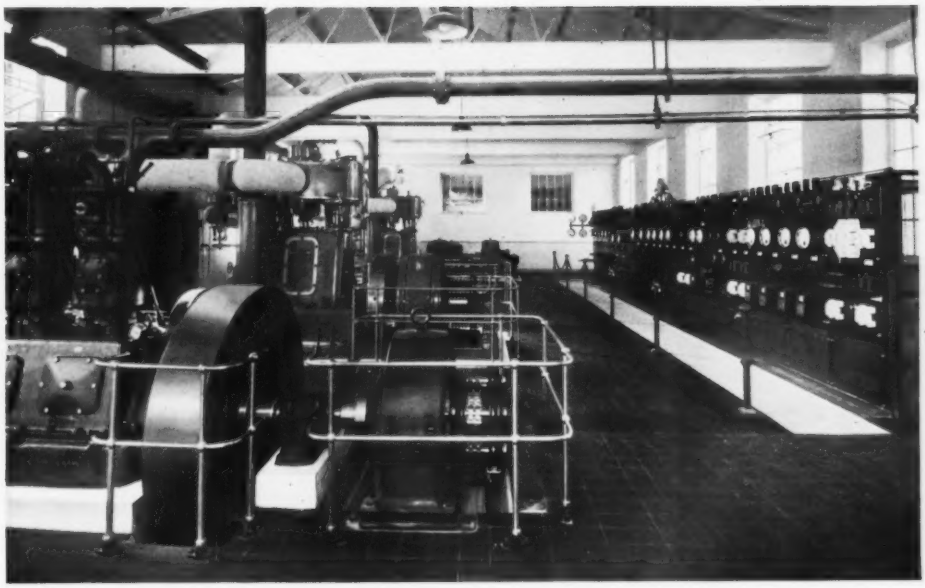


Fig. 5.—Power Plant and Main Switchboard at Milborne Dairy.

in Fig. 4, is controlled by float switches operated from the water level in the two reservoirs, and depth indicators are installed in the pump house and in the power house at Milborne.

Before describing the power house plant it may be of interest to refer briefly to the activities carried on in the central dairy. One of the most important decisions made in the initial stages of the undertaking was that the ordinary system of using glass bottles was quite unsuitable for the delivery of milk which had been handled under the most hygienic conditions to ensure the highest possible standard of purity. It was recognised that thorough cleansing of the bottles was a difficult and expensive process, and that there would be a considerable wastage due to breakages. A form of container constructed of specially selected paper was therefore devised and the necessary machinery installed for its manufacture on a large scale. These containers are sterilised and coated in a wax bath at a high temperature, and filled with milk and sealed in a few seconds under the best possible conditions ; they are not, of course, returnable. The buildings contain a fully equipped laboratory for making bacteriological examinations of milk and for carrying out all tests required in connection with the other activities throughout the estate. All milk is continuously tested both when received and before it is sent out.

In addition to the milk produced on the estate, the Dairy purchases from farmers over a considerable area of Dorset.

When delivered, the milk is run into large receiving vats, from which it is sucked into the tanks where it is pasteurised and cooled. It is then conveyed by pipe lines to the filling machines. After packing, the cartons are placed in cold store before being despatched the same day to London and other parts of the country ; the demand at present far exceeds the supply. In addition to the milk plant, the Dairy has a large cheese-making plant equipped with the latest types of machinery, some of which was brought from New Zealand. There are also a butter-making department, an installation for the manufacture of dried milk, and one for the conversion of whey into various forms for incorporation in animal foods and for other purposes, and into sugar of milk, which is used

in the preparation of infants' foods and certain medicines.

The power house at Milborne, Fig. 5, runs parallel with the dairy, and the two are connected by an underground subway, through which all electric conductors, brine pipes, etc., are carried. It has been laid out with a view to considerable extensions when the area of the undertaking is increased. The demands on the power house plant can be roughly classified under the following heads :—

(*a*) Small quantities of steam at irregular intervals for sterilisation and cleaning purposes.

(*b*) Larger quantities of steam for pasteurising purposes and for the manufacture of whey bye-products.

(*c*) Electricity supply for all purposes, including the lighting of cottages, lighting and power purposes on the farms in the vicinity, and power for driving the refrigerating plant and other machinery in the central dairy.

The main power plant installed consists of one 66 kW. 250-volt oil engine unit and three 150 kW. steam engine driven generators ; of the latter, one supplies current at 250 volts, a second at 500 volts, and the third has two generators, one for each pressure. The steam engines are compound units supplied at a pressure of 147 lbs. per square inch and exhausting at 15 lbs. per square inch.

Experience has shown that a subdivision of the plant in the manner described gives highly economical results under the somewhat special conditions that exist. When exhaust steam is required and the demand for electric power is considerable, the steam engines are able to meet both requirements, but when electric power only is being called for it can be furnished by the oil engine set. Steam is provided by three 14 ft. by 8 ft. horizontal boilers, each having an evaporation of 7,000 lbs. per hour ; they are fired with oil fuel in order to obviate the dust and dirt inseparable from coal firing, but the design is such that they can be easily converted for the use of coal at any time. Fuel storage is provided in the form of six 20-ton tanks. The power supply is controlled from an 18-panel switchboard, which includes generator, booster and battery panels and nine feeder panels. All supplies are metered, and each department is charged a fixed price for power and lighting, as well as for water and steam ; records of all services are charted and careful comparison of costs checked.

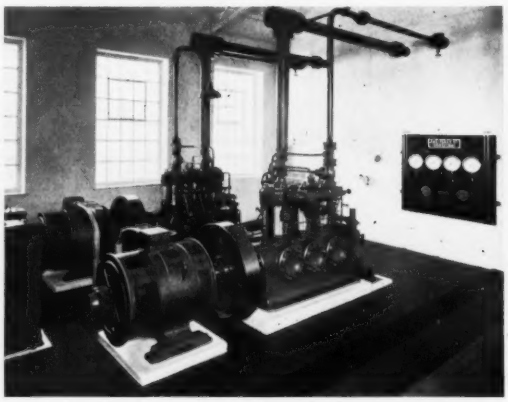


Fig. 6.—Compressors for Refrigerating Plant at Milborne.

In the evaporator room of the power house are installed two ammonia evaporators, each driven by a 50 H.P. 500-volt motor. This plant is capable of pre-cooling 2,000 gallons of milk per hour, and at the same time cooling the same quantity after pasteurising, and also maintaining the required temperature in the cold storage department.

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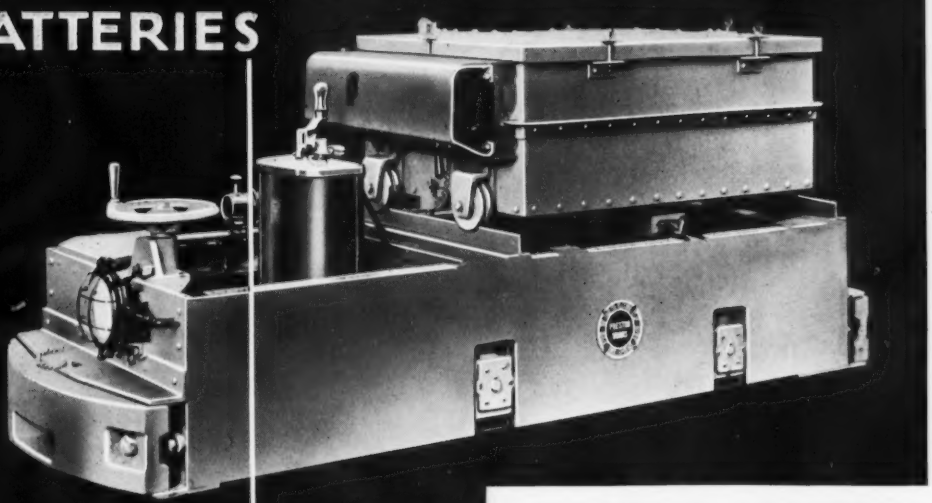

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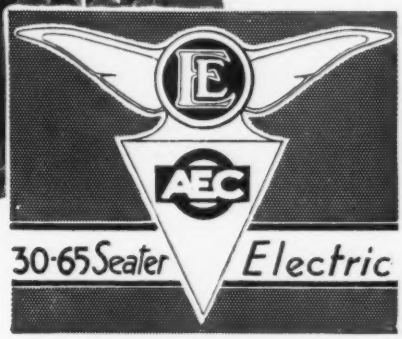

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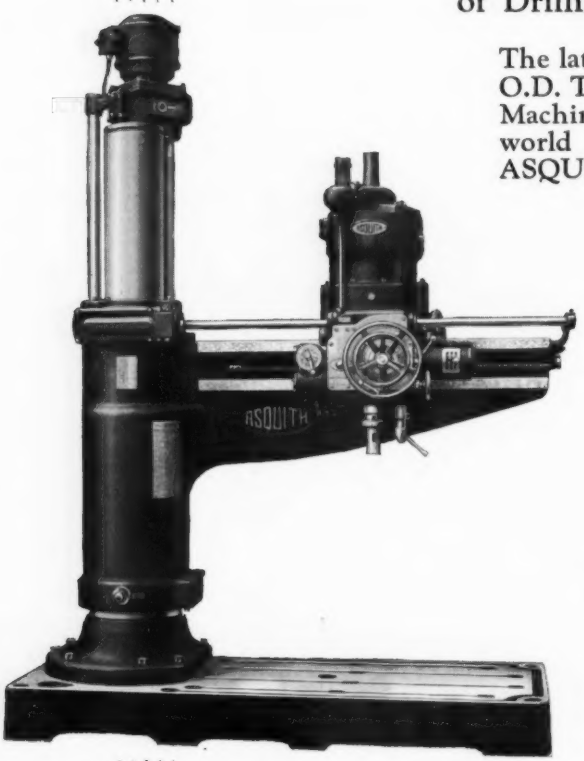

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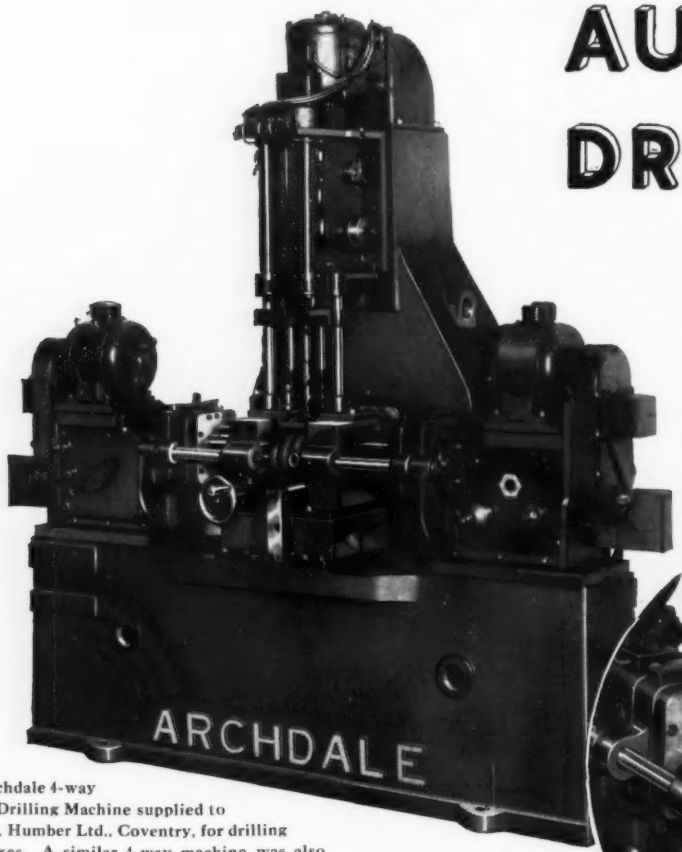

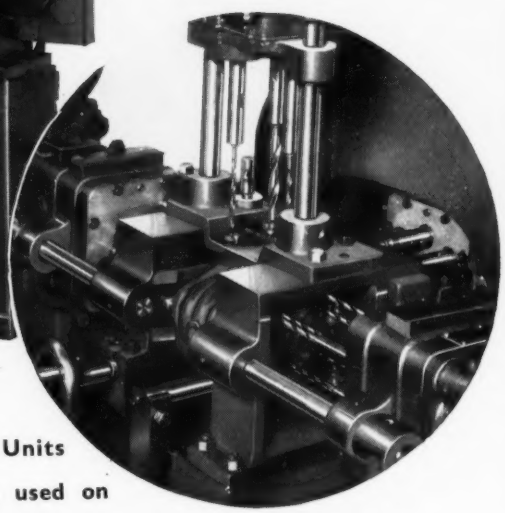

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